Origins

10/28/2009

Opening Discussion

- http://www.youtube.com/watch?v=Qdb4NyHdFfE
- Have you seen anything interesting in the news?
- What did we talk about last class?
- Minute Essays
  - Difficulty in hiring graders.
  - Feelings on open book and other things.

Search for Origins

- One of the most fundamental questions of science is, “Where did we come from?”
- A large part of this question lies in the field of astronomy.
- We have already mentioned the Big Bang theory for the origin of the Universe.
- What about our solar system? When and how did our Sun and its host of planets and other bodies form?

Significant Solar System Properties

- There are a number of properties of our solar system that any formation hypothesis has to match.
  - Patterns of motion
    - Spinning the same way
    - Single plane
  - Terrestrial vs. jovian planets
  - Existence of small bodies
  - Allow for the exceptions

The Nebular Hypothesis

- Originally developed independently by Kant and Laplace.
- A giant cloud of gas collapses to form the star.
- A disk of material around it leads to the formation of planets.
- This happened for our solar system about 4.5 billion years ago.
- Now this is the nebular theory because it is so well supported.

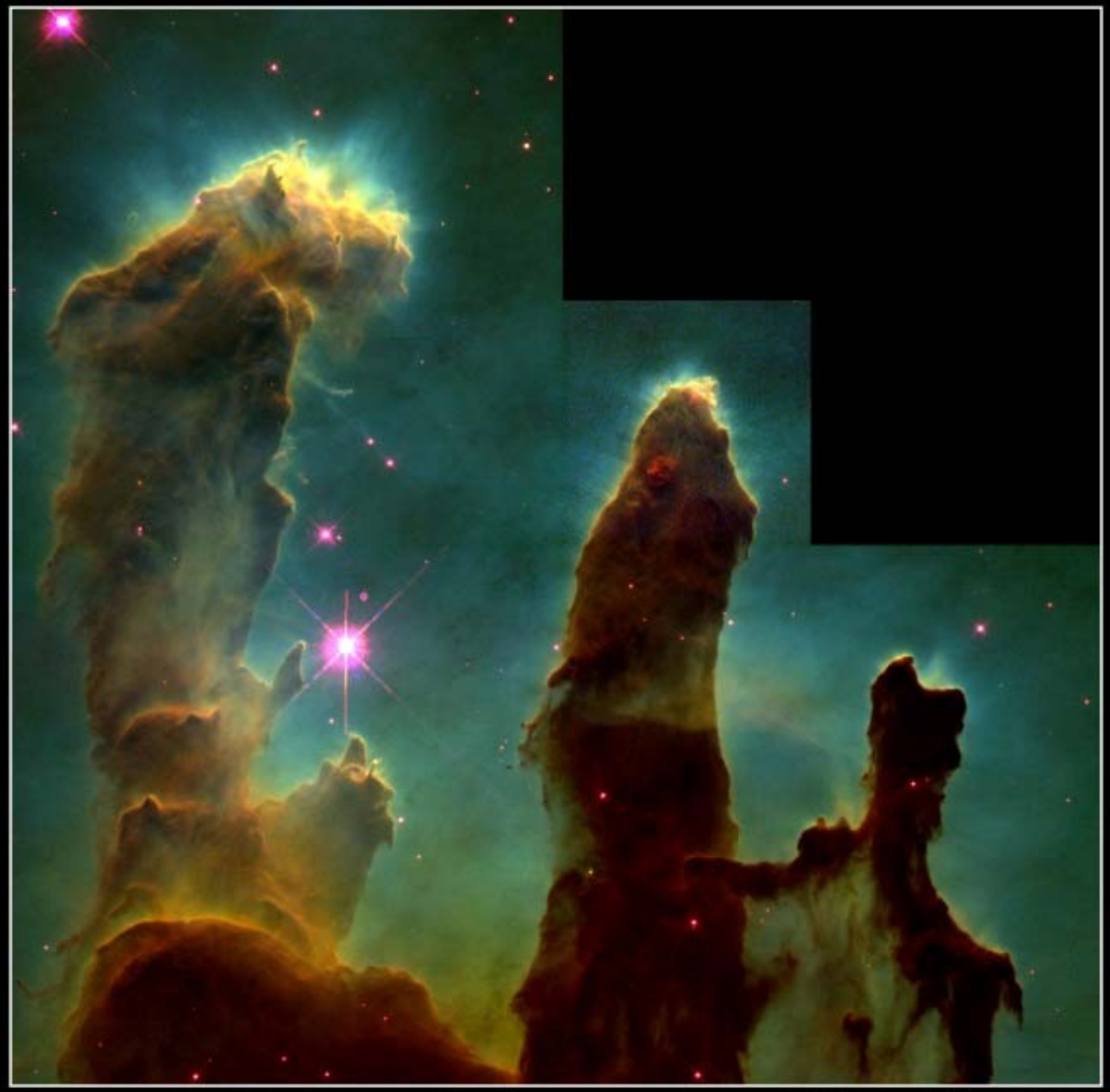
Close Encounter Hypothesis

- (Note: This ones doesn't work!)
- In the early 1900s a second hypothesis become popular.
- The idea was that a second star passed close to our Sun and the gravitational disruption pulled of material that formed the planets.
- Has a few problems:
  - Such encounters are extremely rare.
  - Doesn't reproduce motions of planets.
  - Doesn't produce terrestrial and jovian dichotomy.

Galactic Recycling

- The Nebular theory begins with a giant cloud of gas.
- These clouds are found all through younger galaxies like our own.
- Originally they contained only hydrogen and helium.
- Exploding stars throw heavier elements into them. They can also lead to instability that causes gravitational collapse.

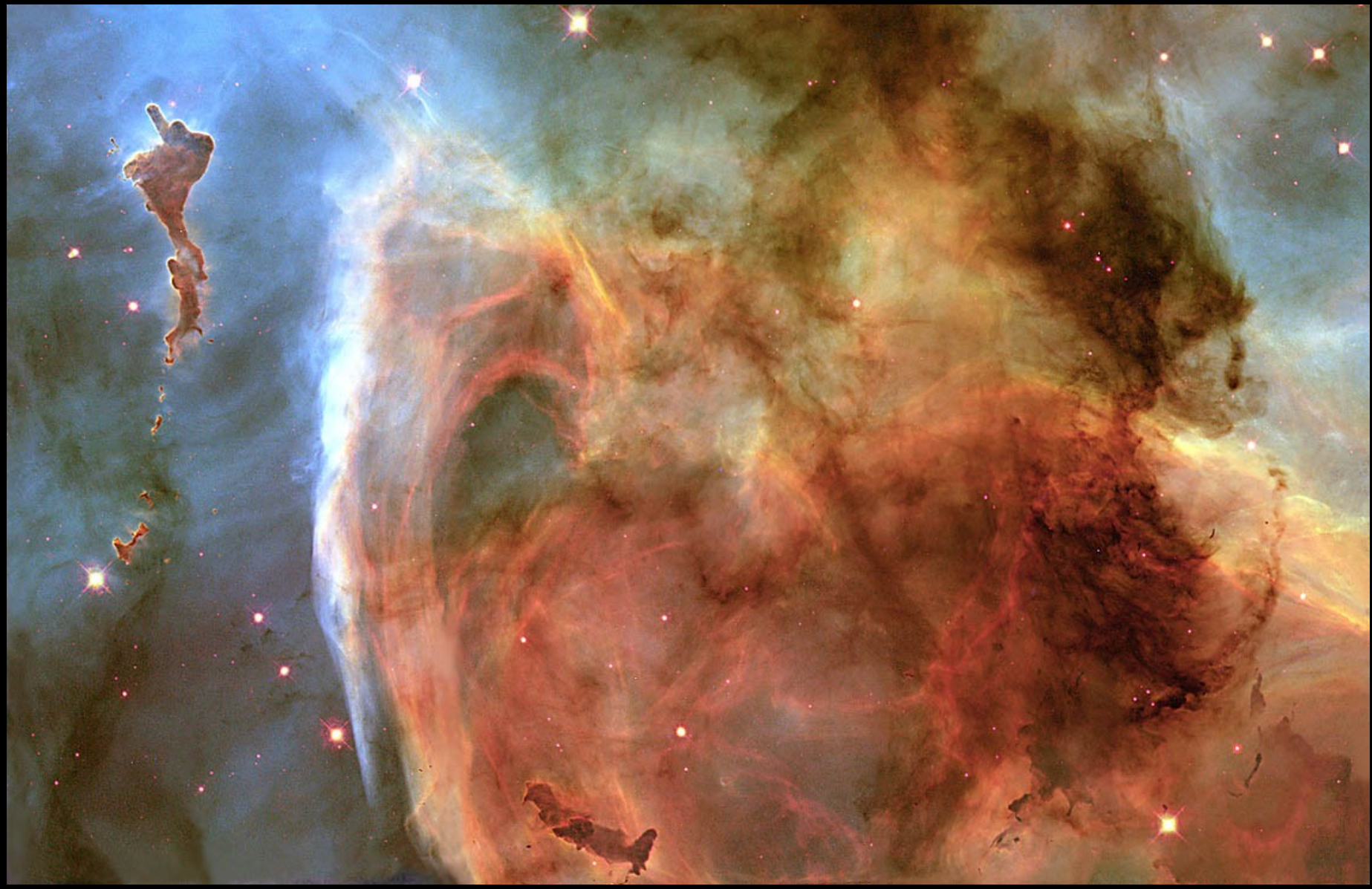
Observations



Gaseous Pillars · M16 HST · WFPC2

PRC95-44a · ST ScI OPO · November 2, 1995
J. Hester and P. Scowen (AZ State Univ.), NASA

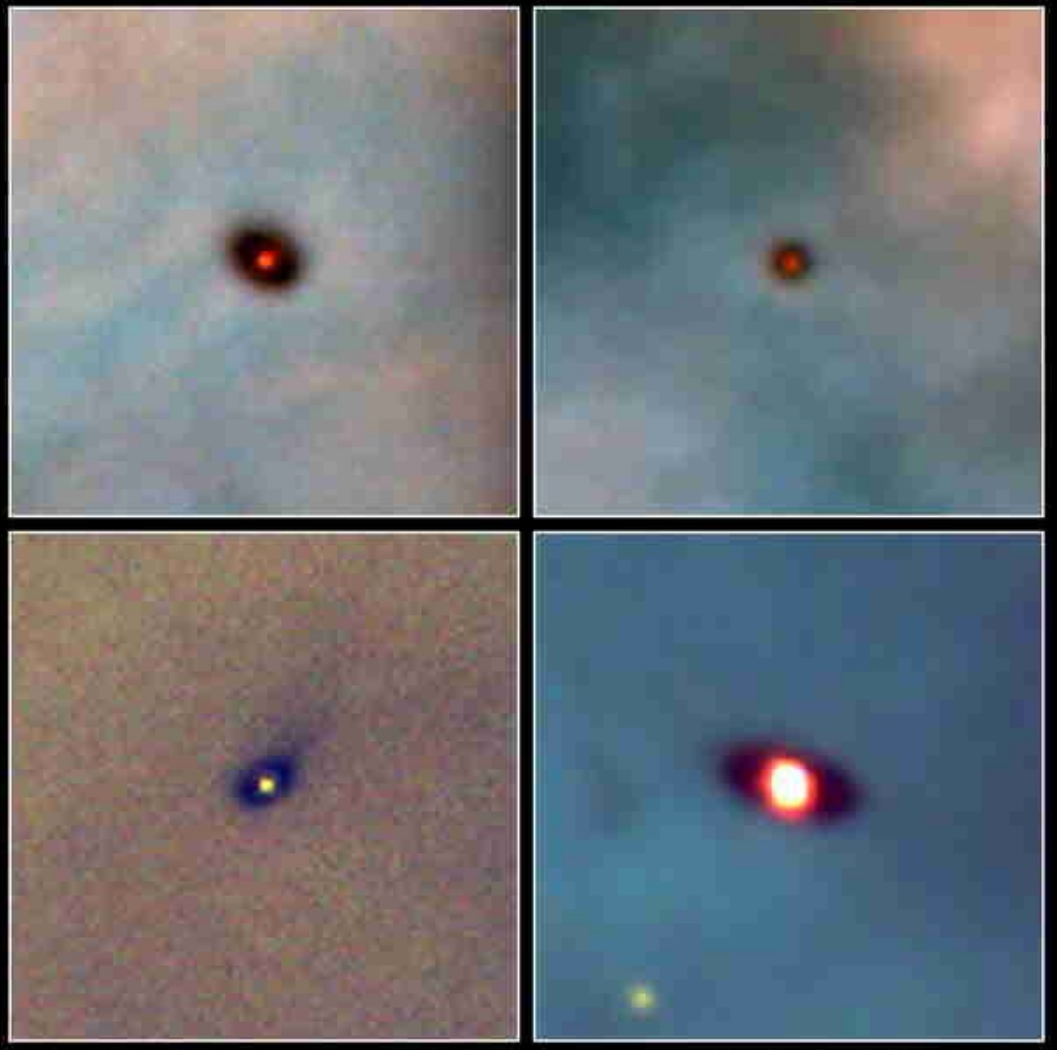
Observations



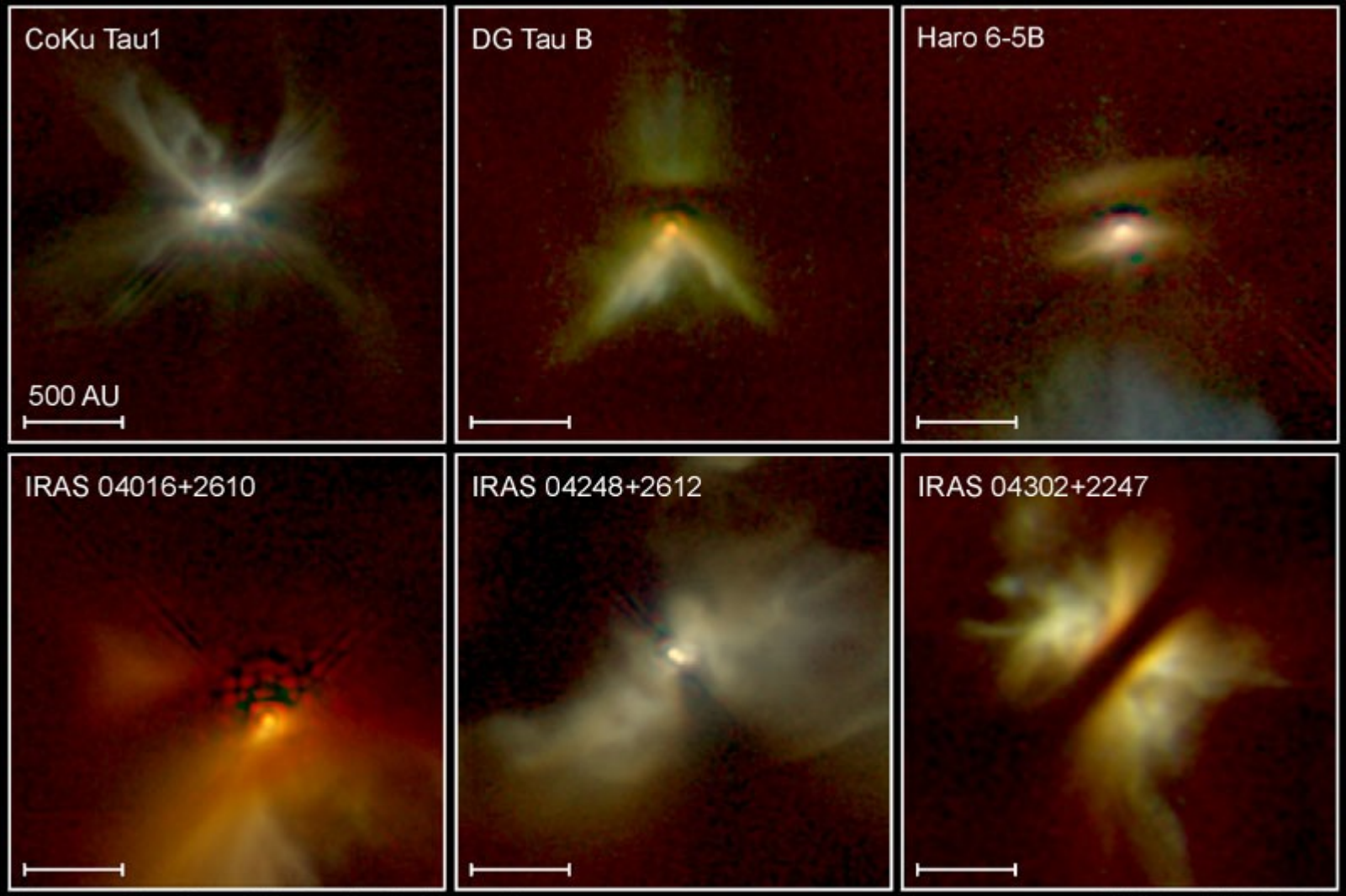
Forming a Hot Disk

- As the gas contracts it heats up. (Some radiative cooling is required to allow collapse to continue.)
- Conservation of angular momentum and averaging of motion in collisions have two effects.
  - The random motions average to a net spin and the spin rate increases dramatically with collapse.
  - The material flattens into a disk.

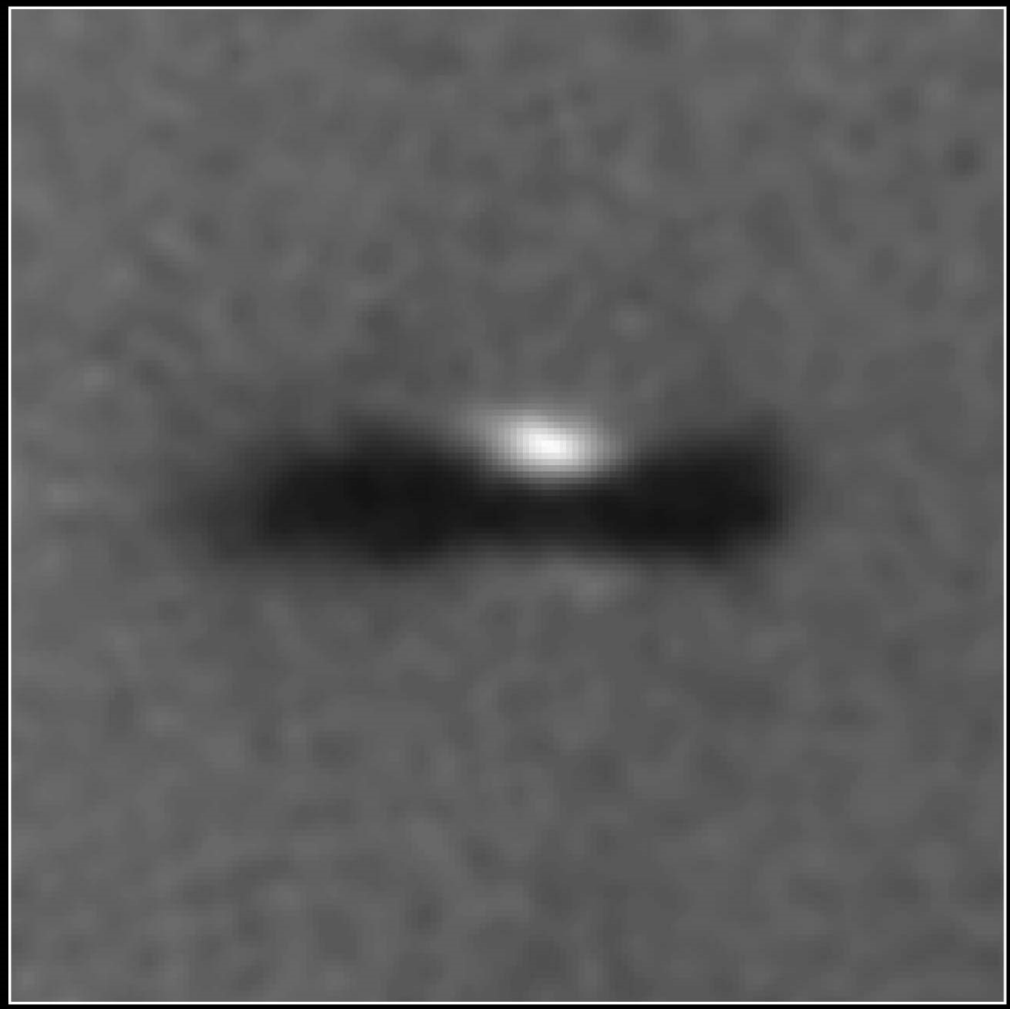
Observations



Observations



Observations

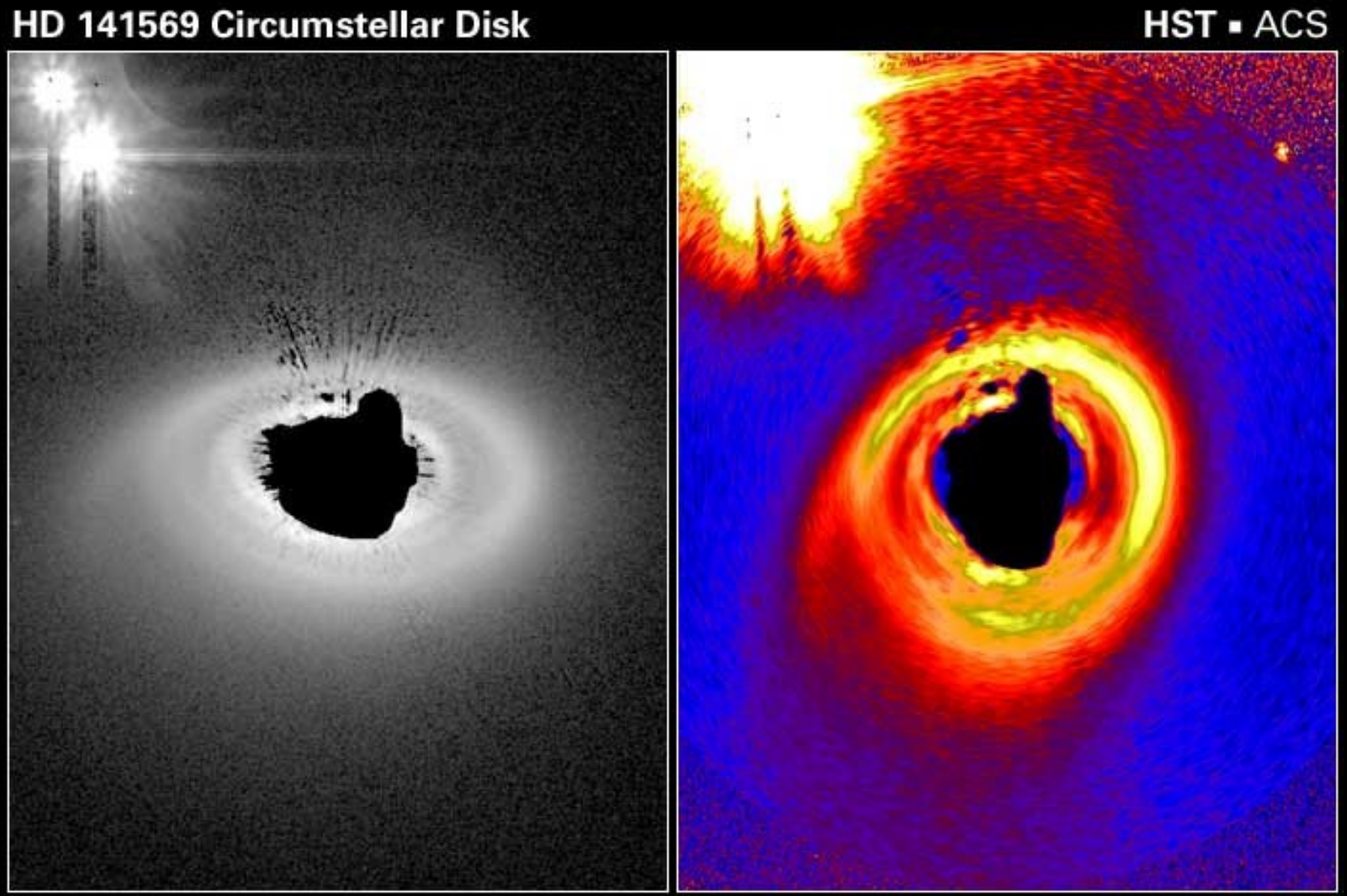


Edge-On Protoplanetary Disk • Orion Nebula

Hubble Space Telescope • Wide Field Planetary Camera 2

PRC95-45c • ST ScI OPO • November 20, 1995 • M. J. McCaughrean (MPIA), C. R. O'Dell (Rice University), NASA

Observations



Minute Essay

Do you have any questions about the formation of our star and the disk around it? Do you understand why the Nebular hypothesis was elevated the the Nebular theory?

We'll look at the formation of planets in the protoplanetary disk next class.